Name: ______________________________________ Date: ____________________

Polynomial Operations SOLUTIONS (version 1)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -x^5 - 5x^3 - 7x^2 - 3x + 9$$

$$q(x) = -6x^5 - 7x^4 + x^3 - 5x + 10$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (-1)x^5 + (0)x^4 + (-5)x^3 + (-7)x^2 + (-3)x^1 + (9)x^0 \\
q(x) &= (-6)x^5 + (-7)x^4 + (1)x^3 + (0)x^2 + (-5)x^1 + (10)x^0 \\
p(x) - q(x) &= (5)x^5 + (7)x^4 + (-6)x^3 + (-7)x^2 + (2)x^1 + (-1)x^0 \\
p(x) - q(x) &= 5x^5 + 7x^4 - 6x^3 - 7x^2 + 2x - 1
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -7x^2 - 2x + 5$$

$$b(x) = 4x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-7x^2$	$-2x$	5
$4x$	$-28x^3$	$-8x^2$	$20x$
7	$-49x^2$	$-14x$	35

$$a(x) \cdot b(x) = -28x^3 - 8x^2 - 49x^2 + 20x - 14x + 35$$

Combine like terms.

$$a(x) \cdot b(x) = -28x^3 - 57x^2 + 6x + 35$$

3. Express $(x+1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 1)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 2x^3 + 14x^2 + 3x + 23 \\ g(x) &= x + 7 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+7}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 2 & 14 & 3 & 23 \\ \text{-7} & & \text{-14} & 0 & \text{-21} \\ \hline & 2 & 0 & 3 & 2 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 2x^2 + 3 + \frac{2}{x+7}$$

In other words, $h(x) = 2x^2 + 3$ and the remainder is $R = 2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 2x^3 + 14x^2 + 3x + 23$. Evaluate $f(-7)$.

You could do this the hard way.

$$\begin{aligned} f(-7) &= (2)\cdot(-7)^3 \ + \ (14)\cdot(-7)^2 \ + \ (3)\cdot(-7) \ + \ (23) \\ &= (2)\cdot(-343) \ + \ (14)\cdot(49) \ + \ (3)\cdot(-7) \ + \ (23) \\ &= (-686) \ + \ (686) \ + \ (-21) \ + \ (23) \\ &= 2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-7)$ equals the remainder when $f(x)$ is divided by $x + 7$. Thus, $f(-7) = 2$.

Name: ______________________________ Date: ______________

Polynomial Operations SOLUTIONS (version 2)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 6x^5 - 8x^3 + x^2 - 5x - 7$$

$$q(x) = 3x^5 - 6x^4 + 8x^3 - 10x + 1$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (6)x^5 + (0)x^4 + (-8)x^3 + (1)x^2 + (-5)x^1 + (-7)x^0 \\ q(x) &= (3)x^5 + (-6)x^4 + (8)x^3 + (0)x^2 + (-10)x^1 + (1)x^0 \\ p(x) + q(x) &= (9)x^5 + (-6)x^4 + (0)x^3 + (1)x^2 + (-15)x^1 + (-6)x^0 \\ p(x) + q(x) &= 9x^5 - 6x^4 + x^2 - 15x - 6 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 6x^2 - 7x + 8$$

$$b(x) = -4x - 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$6x^2$	$-7x$	8
$-4x$	$-24x^3$	$28x^2$	$-32x$
-5	$-30x^2$	$35x$	-40

$$a(x) \cdot b(x) = -24x^3 + 28x^2 - 30x^2 - 32x + 35x - 40$$

Combine like terms.

$$a(x) \cdot b(x) = -24x^3 - 2x^2 + 3x - 40$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 2)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 6x^3 - 25x^2 + 4x + 6 \\ g(x) &= x - 4 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-4}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 6 & -25 & 4 & 6 \\ 4 & & 24 & -4 & 0 \\ \hline & 6 & -1 & 0 & 6 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 6x^2 - x + \frac{6}{x-4}$$

In other words, $h(x) = 6x^2 - x$ and the remainder is $R = 6$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 6x^3 - 25x^2 + 4x + 6$. Evaluate $f(4)$.

You could do this the hard way.

$$\begin{aligned} f(4) &= (6) \cdot (4)^3 \; + \; (-25) \cdot (4)^2 \; + \; (4) \cdot (4) \; + \; (6) \\ &= (6) \cdot (64) \; + \; (-25) \cdot (16) \; + \; (4) \cdot (4) \; + \; (6) \\ &= (384) \; + \; (-400) \; + \; (16) \; + \; (6) \\ &= 6 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(4)$ equals the remainder when $f(x)$ is divided by $x - 4$. Thus, $f(4) = 6$.

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Polynomial Operations SOLUTIONS (version 3)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -7x^5 + 2x^3 + 3x^2 + 9x - 8$$

$$q(x) = 2x^5 + 5x^4 + 9x^2 + x - 6$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-7)x^5 + (0)x^4 + (2)x^3 + (3)x^2 + (9)x^1 + (-8)x^0 \\ q(x) &= (2)x^5 + (5)x^4 + (0)x^3 + (9)x^2 + (1)x^1 + (-6)x^0 \\ p(x) - q(x) &= (-9)x^5 + (-5)x^4 + (2)x^3 + (-6)x^2 + (8)x^1 + (-2)x^0 \\ p(x) - q(x) &= -9x^5 - 5x^4 + 2x^3 - 6x^2 + 8x - 2 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 5x^2 - 4x + 7$$

$$b(x) = -4x - 6$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$5x^2$	$-4x$	7
$-4x$	$-20x^3$	$16x^2$	$-28x$
-6	$-30x^2$	$24x$	-42

$$a(x) \cdot b(x) = -20x^3 + 16x^2 - 30x^2 - 28x + 24x - 42$$

Combine like terms.

$$a(x) \cdot b(x) = -20x^3 - 14x^2 - 4x - 42$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 3)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -2x^3 + 19x^2 - 23x - 5 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -2 & 19 & -23 & -5 \\ 8 & & -16 & 24 & 8 \\ \hline & -2 & 3 & 1 & 3 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -2x^2 + 3x + 1 + \frac{3}{x-8}$$

In other words, $h(x) = -2x^2 + 3x + 1$ and the remainder is $R = 3$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -2x^3 + 19x^2 - 23x - 5$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (-2)\cdot(8)^3 \ + \ (19)\cdot(8)^2 \ + \ (-23)\cdot(8) \ + \ (-5) \\ &= (-2)\cdot(512) \ + \ (19)\cdot(64) \ + \ (-23)\cdot(8) \ + \ (-5) \\ &= (-1024) \ + \ (1216) \ + \ (-184) \ + \ (-5) \\ &= 3 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = 3$.

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Polynomial Operations SOLUTIONS (version 4)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 3x^5 - 10x^4 + 7x^3 + 4x^2 + 5$$

$$q(x) = -2x^5 - 8x^4 + x^3 - 3x - 6$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (3)x^5 + (-10)x^4 + (7)x^3 + (4)x^2 + (0)x^1 + (5)x^0 \\ q(x) &= (-2)x^5 + (-8)x^4 + (1)x^3 + (0)x^2 + (-3)x^1 + (-6)x^0 \\ p(x) - q(x) &= (5)x^5 + (-2)x^4 + (6)x^3 + (4)x^2 + (3)x^1 + (11)x^0 \\ p(x) - q(x) &= 5x^5 - 2x^4 + 6x^3 + 4x^2 + 3x + 11 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 2x^2 + 7x - 4$$

$$b(x) = 5x + 2$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$2x^2$	$7x$	-4
$5x$	$10x^3$	$35x^2$	$-20x$
2	$4x^2$	$14x$	-8

$$a(x) \cdot b(x) = 10x^3 + 35x^2 + 4x^2 - 20x + 14x - 8$$

Combine like terms.

$$a(x) \cdot b(x) = 10x^3 + 39x^2 - 6x - 8$$

3. Express $(x+1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 4)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -3x^3 - 16x^2 + 7x - 26 \\ g(x) &= x + 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -3 & -16 & 7 & -26 \\ -6 & & 18 & -12 & 30 \\ \hline & -3 & 2 & -5 & 4 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -3x^2 + 2x - 5 + \frac{4}{x+6}$$

In other words, $h(x) = -3x^2 + 2x - 5$ and the remainder is $R = 4$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -3x^3 - 16x^2 + 7x - 26$. Evaluate $f(-6)$.

You could do this the hard way.

$$\begin{aligned} f(-6) &= (-3)\cdot(-6)^3 \;+\; (-16)\cdot(-6)^2 \;+\; (7)\cdot(-6) \;+\; (-26) \\ &= (-3)\cdot(-216) \;+\; (-16)\cdot(36) \;+\; (7)\cdot(-6) \;+\; (-26) \\ &= (648) \;+\; (-576) \;+\; (-42) \;+\; (-26) \\ &= 4 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-6)$ equals the remainder when $f(x)$ is divided by $x+6$. Thus, $f(-6) = 4$.

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Polynomial Operations SOLUTIONS (version 5)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -9x^5 + 10x^4 - 5x^2 - 6x + 3$$
$$q(x) = -10x^5 + 5x^4 - 8x^3 + x - 4$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-9)x^5 + (10)x^4 + (0)x^3 + (-5)x^2 + (-6)x^1 + (3)x^0 \\ q(x) &= (-10)x^5 + (5)x^4 + (-8)x^3 + (0)x^2 + (1)x^1 + (-4)x^0 \\ p(x) + q(x) &= (-19)x^5 + (15)x^4 + (-8)x^3 + (-5)x^2 + (-5)x^1 + (-1)x^0 \\ p(x) + q(x) &= -19x^5 + 15x^4 - 8x^3 - 5x^2 - 5x - 1 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -3x^2 - 7x - 5$$
$$b(x) = 4x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-3x^2$	$-7x$	-5
$4x$	$-12x^3$	$-28x^2$	$-20x$
7	$-21x^2$	$-49x$	-35

$$a(x) \cdot b(x) = -12x^3 - 28x^2 - 21x^2 - 20x - 49x - 35$$

Combine like terms.

$$a(x) \cdot b(x) = -12x^3 - 49x^2 - 69x - 35$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 5)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -2x^3 - 7x^2 + 14x - 11 \\ g(x) &= x + 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -2 & -7 & 14 & -11 \\ -5 & & 10 & -15 & 5 \\ \hline & -2 & 3 & -1 & -6 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -2x^2 + 3x - 1 + \frac{-6}{x+5}$$

In other words, $h(x) = -2x^2 + 3x - 1$ and the remainder is $R = -6$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -2x^3 - 7x^2 + 14x - 11$. Evaluate $f(-5)$.

You could do this the hard way.

$$\begin{aligned} f(-5) &= (-2)\cdot(-5)^3 \ + \ (-7)\cdot(-5)^2 \ + \ (14)\cdot(-5) \ + \ (-11) \\ &= (-2)\cdot(-125) \ + \ (-7)\cdot(25) \ + \ (14)\cdot(-5) \ + \ (-11) \\ &= (250) \ + \ (-175) \ + \ (-70) \ + \ (-11) \\ &= -6 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-5)$ equals the remainder when $f(x)$ is divided by $x+5$. Thus, $f(-5) = -6$.

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Polynomial Operations SOLUTIONS (version 6)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 9x^3 + 3x^2 - x - 2$$

$$q(x) = -5x^5 + 8x^4 + 6x^2 + 9x + 2$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (8)x^5 + (0)x^4 + (9)x^3 + (3)x^2 + (-1)x^1 + (-2)x^0 \\
q(x) &= (-5)x^5 + (8)x^4 + (0)x^3 + (6)x^2 + (9)x^1 + (2)x^0 \\
q(x) - p(x) &= (-13)x^5 + (8)x^4 + (-9)x^3 + (3)x^2 + (10)x^1 + (4)x^0 \\
q(x) - p(x) &= -13x^5 + 8x^4 - 9x^3 + 3x^2 + 10x + 4
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 6x^2 - 8x + 5$$

$$b(x) = -3x - 6$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$6x^2$	$-8x$	5
$-3x$	$-18x^3$	$24x^2$	$-15x$
-6	$-36x^2$	$48x$	-30

$$a(x) \cdot b(x) = -18x^3 + 24x^2 - 36x^2 - 15x + 48x - 30$$

Combine like terms.

$$a(x) \cdot b(x) = -18x^3 - 12x^2 + 33x - 30$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 6)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -2x^3 + 19x^2 - 11x + 23 \\ g(x) &= x - 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & -2 & 19 & -11 & 23 \\ 9 & & -18 & 9 & -18 \\ \hline & -2 & 1 & -2 & 5 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -2x^2 + x - 2 + \frac{5}{x-9}$$

In other words, $h(x) = -2x^2 + x - 2$ and the remainder is $R = 5$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -2x^3 + 19x^2 - 11x + 23$. Evaluate $f(9)$.

You could do this the hard way.

$$\begin{aligned} f(9) &= (-2)\cdot(9)^3 + (19)\cdot(9)^2 + (-11)\cdot(9) + (23) \\ &= (-2)\cdot(729) + (19)\cdot(81) + (-11)\cdot(9) + (23) \\ &= (-1458) + (1539) + (-99) + (23) \\ &= 5 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(9)$ equals the remainder when $f(x)$ is divided by $x - 9$. Thus, $f(9) = 5$.

Name: ____ Date: ____________________

Polynomial Operations SOLUTIONS (version 7)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 7x^5 + 2x^4 - 9x^2 + 6x - 3$$

$$q(x) = -10x^5 + 3x^4 - 4x^3 + 6x - 9$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (7)x^5 + (2)x^4 + (0)x^3 + (-9)x^2 + (6)x^1 + (-3)x^0 \\ q(x) &= (-10)x^5 + (3)x^4 + (-4)x^3 + (0)x^2 + (6)x^1 + (-9)x^0 \\ p(x) - q(x) &= (17)x^5 + (-1)x^4 + (4)x^3 + (-9)x^2 + (0)x^1 + (6)x^0 \\ p(x) - q(x) &= 17x^5 - x^4 + 4x^3 - 9x^2 + 6 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 5x^2 + 7x - 4$$

$$b(x) = 4x - 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$5x^2$	$7x$	-4
$4x$	$20x^3$	$28x^2$	$-16x$
-7	$-35x^2$	$-49x$	28

$$a(x) \cdot b(x) = 20x^3 + 28x^2 - 35x^2 - 16x - 49x + 28$$

Combine like terms.

$$a(x) \cdot b(x) = 20x^3 - 7x^2 - 65x + 28$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 7)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 - 6x^2 - 19x + 26 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & 1 & -6 & -19 & 26 \\ 8 & & 8 & 16 & -24 \\ \hline & 1 & 2 & -3 & 2 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = x^2 + 2x - 3 + \frac{2}{x-8}$$

In other words, $h(x) = x^2 + 2x - 3$ and the remainder is $R = 2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 - 6x^2 - 19x + 26$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (1)\cdot(8)^3 \ + \ (-6)\cdot(8)^2 \ + \ (-19)\cdot(8) \ + \ (26) \\ &= (1)\cdot(512) \ + \ (-6)\cdot(64) \ + \ (-19)\cdot(8) \ + \ (26) \\ &= (512) \ + \ (-384) \ + \ (-152) \ + \ (26) \\ &= 2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = 2$.

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Polynomial Operations SOLUTIONS (version 8)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -2x^5 + 7x^4 - 10x^3 - 9x^2 + 1$$

$$q(x) = 4x^5 + 8x^4 - 10x^3 - x - 7$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-2)x^5 + (7)x^4 + (-10)x^3 + (-9)x^2 + (0)x^1 + (1)x^0 \\ q(x) &= (4)x^5 + (8)x^4 + (-10)x^3 + (0)x^2 + (-1)x^1 + (-7)x^0 \\ p(x) - q(x) &= (-6)x^5 + (-1)x^4 + (0)x^3 + (-9)x^2 + (1)x^1 + (8)x^0 \\ p(x) - q(x) &= -6x^5 - x^4 - 9x^2 + x + 8 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 8x^2 - 3x - 6$$

$$b(x) = 3x - 6$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$8x^2$	$-3x$	-6
$3x$	$24x^3$	$-9x^2$	$-18x$
-6	$-48x^2$	$18x$	36

$$a(x) \cdot b(x) = 24x^3 - 9x^2 - 48x^2 - 18x + 18x + 36$$

Combine like terms.

$$a(x) \cdot b(x) = 24x^3 - 57x^2 + 36$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 8)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -3x^3 + 29x^2 - 19x + 15 \\ g(x) &= x - 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & -3 & 29 & -19 & 15 \\ 9 & & -27 & 18 & -9 \\ \hline & -3 & 2 & -1 & 6 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -3x^2 + 2x - 1 + \frac{6}{x-9}$$

In other words, $h(x) = -3x^2 + 2x - 1$ and the remainder is $R = 6$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -3x^3 + 29x^2 - 19x + 15$. Evaluate $f(9)$.

You could do this the hard way.

$$\begin{aligned} f(9) &= (-3)\cdot(9)^3 \; + \; (29)\cdot(9)^2 \; + \; (-19)\cdot(9) \; + \; (15) \\ &= (-3)\cdot(729) \; + \; (29)\cdot(81) \; + \; (-19)\cdot(9) \; + \; (15) \\ &= (-2187) \; + \; (2349) \; + \; (-171) \; + \; (15) \\ &= 6 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(9)$ equals the remainder when $f(x)$ is divided by $x - 9$. Thus, $f(9) = 6$.

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Polynomial Operations SOLUTIONS (version 9)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$\begin{aligned} p(x) &= 6x^5 + 8x^4 - 3x^3 - 4x + 7 \\ q(x) &= 3x^5 - 6x^3 + x^2 + 7x + 5 \end{aligned}$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (6)x^5 + (8)x^4 + (-3)x^3 + (0)x^2 + (-4)x^1 + (7)x^0 \\ q(x) &= (3)x^5 + (0)x^4 + (-6)x^3 + (1)x^2 + (7)x^1 + (5)x^0 \\ p(x) - q(x) &= (3)x^5 + (8)x^4 + (3)x^3 + (-1)x^2 + (-11)x^1 + (2)x^0 \\ p(x) - q(x) &= 3x^5 + 8x^4 + 3x^3 - x^2 - 11x + 2 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$\begin{aligned} a(x) &= 4x^2 - 2x - 8 \\ b(x) &= -2x - 5 \end{aligned}$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$4x^2$	$-2x$	-8
$-2x$	$-8x^3$	$4x^2$	$16x$
-5	$-20x^2$	$10x$	40

$$a(x) \cdot b(x) = -8x^3 + 4x^2 - 20x^2 + 16x + 10x + 40$$

Combine like terms.

$$a(x) \cdot b(x) = -8x^3 - 16x^2 + 26x + 40$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 9)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 6x^3 - 24x^2 - 28x - 17 \\ g(x) &= x - 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & 6 & -24 & -28 & -17 \\ 5 & & 30 & 30 & 10 \\ \hline & 6 & 6 & 2 & -7 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 6x^2 + 6x + 2 + \frac{-7}{x-5}$$

In other words, $h(x) = 6x^2 + 6x + 2$ and the remainder is $R = -7$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 6x^3 - 24x^2 - 28x - 17$. Evaluate $f(5)$.

You could do this the hard way.

$$\begin{aligned} f(5) &= (6)\cdot(5)^3 + (-24)\cdot(5)^2 + (-28)\cdot(5) + (-17) \\ &= (6)\cdot(125) + (-24)\cdot(25) + (-28)\cdot(5) + (-17) \\ &= (750) + (-600) + (-140) + (-17) \\ &= -7 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(5)$ equals the remainder when $f(x)$ is divided by $x - 5$. Thus, $f(5) = -7$.

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Polynomial Operations SOLUTIONS (version 10)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -10x^5 + 7x^4 + 8x^3 - 3x - 2$$

$$q(x) = -8x^5 - 6x^3 - 9x^2 + 3x + 2$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-10)x^5 + (7)x^4 + (8)x^3 + (0)x^2 + (-3)x^1 + (-2)x^0 \\ q(x) &= (-8)x^5 + (0)x^4 + (-6)x^3 + (-9)x^2 + (3)x^1 + (2)x^0 \\ p(x) + q(x) &= (-18)x^5 + (7)x^4 + (2)x^3 + (-9)x^2 + (0)x^1 + (0)x^0 \\ p(x) + q(x) &= -18x^5 + 7x^4 + 2x^3 - 9x^2 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -3x^2 - 6x + 9$$

$$b(x) = -3x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-3x^2$	$-6x$	9
$-3x$	$9x^3$	$18x^2$	$-27x$
7	$-21x^2$	$-42x$	63

$$a(x) \cdot b(x) = 9x^3 + 18x^2 - 21x^2 - 27x - 42x + 63$$

Combine like terms.

$$a(x) \cdot b(x) = 9x^3 - 3x^2 - 69x + 63$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 10)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 3x^3 + 21x^2 + 25x - 28 \\ g(x) &= x + 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 3 & 21 & 25 & -28 \\ -5 & & -15 & -30 & 25 \\ \hline & 3 & 6 & -5 & -3 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 3x^2 + 6x - 5 + \frac{-3}{x+5}$$

In other words, $h(x) = 3x^2 + 6x - 5$ and the remainder is $R = -3$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 3x^3 + 21x^2 + 25x - 28$. Evaluate $f(-5)$.

You could do this the hard way.

$$\begin{aligned} f(-5) &= (3)\cdot(-5)^3 \ + \ (21)\cdot(-5)^2 \ + \ (25)\cdot(-5) \ + \ (-28) \\ &= (3)\cdot(-125) \ + \ (21)\cdot(25) \ + \ (25)\cdot(-5) \ + \ (-28) \\ &= (-375) \ + \ (525) \ + \ (-125) \ + \ (-28) \\ &= -3 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-5)$ equals the remainder when $f(x)$ is divided by $x + 5$. Thus, $f(-5) = -3$.

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Polynomial Operations SOLUTIONS (version 11)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 9x^4 + x^2 + 5x + 4$$

$$q(x) = 7x^5 - 5x^4 - 3x^3 + 9x^2 - 10$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (8)x^5 + (9)x^4 + (0)x^3 + (1)x^2 + (5)x^1 + (4)x^0 \\ q(x) &= (7)x^5 + (-5)x^4 + (-3)x^3 + (9)x^2 + (0)x^1 + (-10)x^0 \\ p(x) - q(x) &= (1)x^5 + (14)x^4 + (3)x^3 + (-8)x^2 + (5)x^1 + (14)x^0 \\ p(x) - q(x) &= x^5 + 14x^4 + 3x^3 - 8x^2 + 5x + 14 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -7x^2 + 4x + 8$$

$$b(x) = -6x + 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-7x^2$	$4x$	8
$-6x$	$42x^3$	$-24x^2$	$-48x$
3	$-21x^2$	$12x$	24

$$a(x) \cdot b(x) = 42x^3 - 24x^2 - 21x^2 - 48x + 12x + 24$$

Combine like terms.

$$a(x) \cdot b(x) = 42x^3 - 45x^2 - 36x + 24$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 11)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -x^3 - 8x^2 - 9x + 25 \\ g(x) &= x + 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -1 & -8 & -9 & 25 \\ -6 & & 6 & 12 & -18 \\ \hline & -1 & -2 & 3 & 7 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -x^2 - 2x + 3 + \frac{7}{x+6}$$

In other words, $h(x) = -x^2 - 2x + 3$ and the remainder is $R = 7$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -x^3 - 8x^2 - 9x + 25$. Evaluate $f(-6)$.

You could do this the hard way.

$$\begin{aligned} f(-6) &= (-1)\cdot(-6)^3 \ + \ (-8)\cdot(-6)^2 \ + \ (-9)\cdot(-6) \ + \ (25) \\ &= (-1)\cdot(-216) \ + \ (-8)\cdot(36) \ + \ (-9)\cdot(-6) \ + \ (25) \\ &= (216) \ + \ (-288) \ + \ (54) \ + \ (25) \\ &= 7 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-6)$ equals the remainder when $f(x)$ is divided by $x + 6$. Thus, $f(-6) = 7$.

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Polynomial Operations SOLUTIONS (version 12)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 7x^5 - 5x^4 - 4x^2 + 2x + 3$$
$$q(x) = 10x^5 - 7x^4 + 8x^3 - 5x^2 - 1$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (7)x^5 + (-5)x^4 + (0)x^3 + (-4)x^2 + (2)x^1 + (3)x^0 \\
q(x) &= (10)x^5 + (-7)x^4 + (8)x^3 + (-5)x^2 + (0)x^1 + (-1)x^0 \\
q(x) - p(x) &= (3)x^5 + (-2)x^4 + (8)x^3 + (-1)x^2 + (-2)x^1 + (-4)x^0 \\
q(x) - p(x) &= 3x^5 - 2x^4 + 8x^3 - x^2 - 2x - 4
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 4x^2 - 6x + 5$$
$$b(x) = -8x + 4$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$4x^2$	$-6x$	5
$-8x$	$-32x^3$	$48x^2$	$-40x$
4	$16x^2$	$-24x$	20

$$a(x) \cdot b(x) = -32x^3 + 48x^2 + 16x^2 - 40x - 24x + 20$$

Combine like terms.

$$a(x) \cdot b(x) = -32x^3 + 64x^2 - 64x + 20$$

3. Express $(x+1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 12)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -x^3 + 6x^2 + 16x - 2 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -1 & 6 & 16 & -2 \\ 8 & & -8 & -16 & 0 \\ \hline & -1 & -2 & 0 & -2 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -x^2 - 2x + \frac{-2}{x-8}$$

In other words, $h(x) = -x^2 - 2x$ and the remainder is $R = -2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -x^3 + 6x^2 + 16x - 2$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (-1) \cdot (8)^3 \ + \ (6) \cdot (8)^2 \ + \ (16) \cdot (8) \ + \ (-2) \\ &= (-1) \cdot (512) \ + \ (6) \cdot (64) \ + \ (16) \cdot (8) \ + \ (-2) \\ &= (-512) \ + \ (384) \ + \ (128) \ + \ (-2) \\ &= -2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = -2$.

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Polynomial Operations SOLUTIONS (version 13)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 5x^5 + 6x^4 - 8x^3 - 9x^2 + 10$$
$$q(x) = -7x^5 - 10x^4 + 5x^3 - x + 8$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$p(x) = (5)x^5 + (6)x^4 + (-8)x^3 + (-9)x^2 + (0)x^1 + (10)x^0$$
$$q(x) = (-7)x^5 + (-10)x^4 + (5)x^3 + (0)x^2 + (-1)x^1 + (8)x^0$$
$$q(x) - p(x) = (-12)x^5 + (-16)x^4 + (13)x^3 + (9)x^2 + (-1)x^1 + (-2)x^0$$
$$q(x) - p(x) = -12x^5 - 16x^4 + 13x^3 + 9x^2 - x - 2$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -3x^2 + 2x - 7$$
$$b(x) = 4x - 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-3x^2$	$2x$	-7
$4x$	$-12x^3$	$8x^2$	$-28x$
-7	$21x^2$	$-14x$	49

$$a(x) \cdot b(x) = -12x^3 + 8x^2 + 21x^2 - 28x - 14x + 49$$

Combine like terms.

$$a(x) \cdot b(x) = -12x^3 + 29x^2 - 42x + 49$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 13)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 4x^3 + 22x^2 + 14x + 19 \\ g(x) &= x + 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 4 & 22 & 14 & 19 \\ -5 & & -20 & -10 & -20 \\ \hline & 4 & 2 & 4 & -1 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 4x^2 + 2x + 4 + \frac{-1}{x+5}$$

In other words, $h(x) = 4x^2 + 2x + 4$ and the remainder is $R = -1$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 4x^3 + 22x^2 + 14x + 19$. Evaluate $f(-5)$.

You could do this the hard way.

$$\begin{aligned} f(-5) &= (4)\cdot(-5)^3 \ + \ (22)\cdot(-5)^2 \ + \ (14)\cdot(-5) \ + \ (19) \\ &= (4)\cdot(-125) \ + \ (22)\cdot(25) \ + \ (14)\cdot(-5) \ + \ (19) \\ &= (-500) \ + \ (550) \ + \ (-70) \ + \ (19) \\ &= -1 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-5)$ equals the remainder when $f(x)$ is divided by $x + 5$. Thus, $f(-5) = -1$.

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Polynomial Operations SOLUTIONS (version 14)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -4x^5 - 2x^3 - 7x^2 - x + 6$$

$$q(x) = 7x^5 + x^4 - 6x^3 + 3x^2 - 5$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$p(x) = (-4)x^5 + (0)x^4 + (-2)x^3 + (-7)x^2 + (-1)x^1 + (6)x^0$$
$$q(x) = (7)x^5 + (1)x^4 + (-6)x^3 + (3)x^2 + (0)x^1 + (-5)x^0$$
$$p(x) - q(x) = (-11)x^5 + (-1)x^4 + (4)x^3 + (-10)x^2 + (-1)x^1 + (11)x^0$$
$$p(x) - q(x) = -11x^5 - x^4 + 4x^3 - 10x^2 - x + 11$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -7x^2 - 5x + 3$$

$$b(x) = 3x - 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-7x^2$	$-5x$	3
$3x$	$-21x^3$	$-15x^2$	$9x$
-5	$35x^2$	$25x$	-15

$$a(x) \cdot b(x) = -21x^3 - 15x^2 + 35x^2 + 9x + 25x - 15$$

Combine like terms.

$$a(x) \cdot b(x) = -21x^3 + 20x^2 + 34x - 15$$

3. Express $(x+1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 14)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -x^3 + 9x^2 + 4x - 29 \\ g(x) &= x - 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & -1 & 9 & 4 & -29 \\ 9 & & -9 & 0 & 36 \\ \hline & -1 & 0 & 4 & 7 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -x^2 + 4 + \frac{7}{x-9}$$

In other words, $h(x) = -x^2 + 4$ and the remainder is $R = 7$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -x^3 + 9x^2 + 4x - 29$. Evaluate $f(9)$.

You could do this the hard way.

$$\begin{aligned} f(9) &= (-1)\cdot(9)^3 \;+\; (9)\cdot(9)^2 \;+\; (4)\cdot(9) \;+\; (-29) \\ &= (-1)\cdot(729) \;+\; (9)\cdot(81) \;+\; (4)\cdot(9) \;+\; (-29) \\ &= (-729) \;+\; (729) \;+\; (36) \;+\; (-29) \\ &= 7 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(9)$ equals the remainder when $f(x)$ is divided by $x - 9$. Thus, $f(9) = 7$.

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Polynomial Operations SOLUTIONS (version 15)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -10x^5 + x^3 - 6x^2 + 8x + 5$$

$$q(x) = x^5 + 5x^4 - 9x^3 - 2x - 10$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (-10)x^5 + (0)x^4 + (1)x^3 + (-6)x^2 + (8)x^1 + (5)x^0 \\
q(x) &= (1)x^5 + (5)x^4 + (-9)x^3 + (0)x^2 + (-2)x^1 + (-10)x^0 \\
p(x) - q(x) &= (-11)x^5 + (-5)x^4 + (10)x^3 + (-6)x^2 + (10)x^1 + (15)x^0 \\
p(x) - q(x) &= -11x^5 - 5x^4 + 10x^3 - 6x^2 + 10x + 15
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -5x^2 - 3x + 8$$

$$b(x) = -4x - 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-5x^2$	$-3x$	8
$-4x$	$20x^3$	$12x^2$	$-32x$
-7	$35x^2$	$21x$	-56

$$a(x) \cdot b(x) = 20x^3 + 12x^2 + 35x^2 - 32x + 21x - 56$$

Combine like terms.

$$a(x) \cdot b(x) = 20x^3 + 47x^2 - 11x - 56$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 15)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -5x^3 - 29x^2 + 8x + 9 \\ g(x) &= x + 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -5 & -29 & 8 & 9 \\ -6 & & 30 & -6 & -12 \\ \hline & -5 & 1 & 2 & -3 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -5x^2 + x + 2 + \frac{-3}{x+6}$$

In other words, $h(x) = -5x^2 + x + 2$ and the remainder is $R = -3$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -5x^3 - 29x^2 + 8x + 9$. Evaluate $f(-6)$.

You could do this the hard way.

$$\begin{aligned} f(-6) &= (-5)\cdot(-6)^3 \ + \ (-29)\cdot(-6)^2 \ + \ (8)\cdot(-6) \ + \ (9) \\ &= (-5)\cdot(-216) \ + \ (-29)\cdot(36) \ + \ (8)\cdot(-6) \ + \ (9) \\ &= (1080) \ + \ (-1044) \ + \ (-48) \ + \ (9) \\ &= \ -3 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-6)$ equals the remainder when $f(x)$ is divided by $x + 6$. Thus, $f(-6) = -3$.

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Polynomial Operations SOLUTIONS (version 16)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 - 6x^3 + 10x^2 + 3x - 9$$

$$q(x) = -8x^5 + 6x^4 + x^3 + 3x - 5$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (8)x^5 + (0)x^4 + (-6)x^3 + (10)x^2 + (3)x^1 + (-9)x^0 \\ q(x) &= (-8)x^5 + (6)x^4 + (1)x^3 + (0)x^2 + (3)x^1 + (-5)x^0 \\ p(x) + q(x) &= (0)x^5 + (6)x^4 + (-5)x^3 + (10)x^2 + (6)x^1 + (-14)x^0 \\ p(x) + q(x) &= 6x^4 - 5x^3 + 10x^2 + 6x - 14 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 7x^2 - 5x - 4$$

$$b(x) = -8x + 2$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$7x^2$	$-5x$	-4
$-8x$	$-56x^3$	$40x^2$	$32x$
2	$14x^2$	$-10x$	-8

$$a(x) \cdot b(x) = -56x^3 + 40x^2 + 14x^2 + 32x - 10x - 8$$

Combine like terms.

$$a(x) \cdot b(x) = -56x^3 + 54x^2 + 22x - 8$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 16)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 - 11x^2 + 24x + 9 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 1 & -11 & 24 & 9 \\ 8 & & 8 & -24 & 0 \\ \hline & 1 & -3 & 0 & 9 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = x^2 - 3x + \frac{9}{x-8}$$

In other words, $h(x) = x^2 - 3x$ and the remainder is $R = 9$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 - 11x^2 + 24x + 9$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (1)\cdot(8)^3 + (-11)\cdot(8)^2 + (24)\cdot(8) + (9) \\ &= (1)\cdot(512) + (-11)\cdot(64) + (24)\cdot(8) + (9) \\ &= (512) + (-704) + (192) + (9) \\ &= 9 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = 9$.

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Polynomial Operations SOLUTIONS (version 17)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 7x^5 - 10x^4 + 9x^2 + 2x + 1$$
$$q(x) = -4x^5 - 6x^3 + 3x^2 - 10x + 1$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (7)x^5 + (-10)x^4 + (0)x^3 + (9)x^2 + (2)x^1 + (1)x^0 \\ q(x) &= (-4)x^5 + (0)x^4 + (-6)x^3 + (3)x^2 + (-10)x^1 + (1)x^0 \\ q(x) - p(x) &= (-11)x^5 + (10)x^4 + (-6)x^3 + (-6)x^2 + (-12)x^1 + (0)x^0 \\ q(x) - p(x) &= -11x^5 + 10x^4 - 6x^3 - 6x^2 - 12x \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 2x^2 - 8x - 6$$
$$b(x) = -7x + 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$2x^2$	$-8x$	-6
$-7x$	$-14x^3$	$56x^2$	$42x$
3	$6x^2$	$-24x$	-18

$$a(x) \cdot b(x) = -14x^3 + 56x^2 + 6x^2 + 42x - 24x - 18$$

Combine like terms.

$$a(x) \cdot b(x) = -14x^3 + 62x^2 + 18x - 18$$

3. Express $(x+1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 17)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 2x^3 - 18x^2 + x - 6 \\ g(x) &= x - 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 2 & -18 & 1 & -6 \\ 9 & & 18 & 0 & 9 \\ \hline & 2 & 0 & 1 & 3 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 2x^2 + 1 + \frac{3}{x-9}$$

In other words, $h(x) = 2x^2 + 1$ and the remainder is $R = 3$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 2x^3 - 18x^2 + x - 6$. Evaluate $f(9)$.

You could do this the hard way.

$$\begin{aligned} f(9) &= (2)\cdot(9)^3 \ + \ (-18)\cdot(9)^2 \ + \ (1)\cdot(9) \ + \ (-6) \\ &= (2)\cdot(729) \ + \ (-18)\cdot(81) \ + \ (1)\cdot(9) \ + \ (-6) \\ &= (1458) \ + \ (-1458) \ + \ (9) \ + \ (-6) \\ &= 3 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(9)$ equals the remainder when $f(x)$ is divided by $x - 9$. Thus, $f(9) = 3$.

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Polynomial Operations SOLUTIONS (version 18)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -2x^5 + 6x^4 - 4x^2 + 3x + 7$$

$$q(x) = -x^5 - 5x^3 - 8x^2 + 7x + 3$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$p(x) = (-2)x^5 + (6)x^4 + (0)x^3 + (-4)x^2 + (3)x^1 + (7)x^0$$
$$q(x) = (-1)x^5 + (0)x^4 + (-5)x^3 + (-8)x^2 + (7)x^1 + (3)x^0$$
$$q(x) - p(x) = (1)x^5 + (-6)x^4 + (-5)x^3 + (-4)x^2 + (4)x^1 + (-4)x^0$$
$$q(x) - p(x) = x^5 - 6x^4 - 5x^3 - 4x^2 + 4x - 4$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -2x^2 - 5x - 8$$

$$b(x) = 8x - 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-2x^2$	$-5x$	-8
$8x$	$-16x^3$	$-40x^2$	$-64x$
-5	$10x^2$	$25x$	40

$$a(x) \cdot b(x) = -16x^3 - 40x^2 + 10x^2 - 64x + 25x + 40$$

Combine like terms.

$$a(x) \cdot b(x) = -16x^3 - 30x^2 - 39x + 40$$

3. Express $(x+1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 18)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -6x^3 + 27x^2 + 18x - 13 \\ g(x) &= x - 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -6 & 27 & 18 & -13 \\ 5 & & -30 & -15 & 15 \\ \hline & -6 & -3 & 3 & 2 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -6x^2 - 3x + 3 + \frac{2}{x-5}$$

In other words, $h(x) = -6x^2 - 3x + 3$ and the remainder is $R = 2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -6x^3 + 27x^2 + 18x - 13$. Evaluate $f(5)$.

You could do this the hard way.

$$\begin{aligned} f(5) &= (-6) \cdot (5)^3 \ + \ (27) \cdot (5)^2 \ + \ (18) \cdot (5) \ + \ (-13) \\ &= (-6) \cdot (125) \ + \ (27) \cdot (25) \ + \ (18) \cdot (5) \ + \ (-13) \\ &= (-750) \ + \ (675) \ + \ (90) \ + \ (-13) \\ &= 2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(5)$ equals the remainder when $f(x)$ is divided by $x - 5$. Thus, $f(5) = 2$.

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Polynomial Operations SOLUTIONS (version 19)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -6x^5 - 5x^3 - 2x^2 - x + 9$$

$$q(x) = -4x^5 - 10x^4 - 7x^2 - 5x + 9$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-6)x^5 + (0)x^4 + (-5)x^3 + (-2)x^2 + (-1)x^1 + (9)x^0 \\ q(x) &= (-4)x^5 + (-10)x^4 + (0)x^3 + (-7)x^2 + (-5)x^1 + (9)x^0 \\ q(x) - p(x) &= (2)x^5 + (-10)x^4 + (5)x^3 + (-5)x^2 + (-4)x^1 + (0)x^0 \\ q(x) - p(x) &= 2x^5 - 10x^4 + 5x^3 - 5x^2 - 4x \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -6x^2 - 5x + 8$$

$$b(x) = 3x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-6x^2$	$-5x$	8
$3x$	$-18x^3$	$-15x^2$	$24x$
7	$-42x^2$	$-35x$	56

$$a(x) \cdot b(x) = -18x^3 - 15x^2 - 42x^2 + 24x - 35x + 56$$

Combine like terms.

$$a(x) \cdot b(x) = -18x^3 - 57x^2 - 11x + 56$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 19)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 - 10x^2 + 26x - 4 \\ g(x) &= x - 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	1	-10	26	-4
6		6	-24	12
	1	-4	2	8

So,

$$\frac{f(x)}{g(x)} = x^2 - 4x + 2 + \frac{8}{x-6}$$

In other words, $h(x) = x^2 - 4x + 2$ and the remainder is $R = 8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 - 10x^2 + 26x - 4$. Evaluate $f(6)$.

You could do this the hard way.

$$\begin{aligned} f(6) &= (1)\cdot(6)^3 \ + \ (-10)\cdot(6)^2 \ + \ (26)\cdot(6) \ + \ (-4) \\ &= (1)\cdot(216) \ + \ (-10)\cdot(36) \ + \ (26)\cdot(6) \ + \ (-4) \\ &= (216) \ + \ (-360) \ + \ (156) \ + \ (-4) \\ &= 8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(6)$ equals the remainder when $f(x)$ is divided by $x - 6$. Thus, $f(6) = 8$.

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Polynomial Operations SOLUTIONS (version 20)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -8x^5 - 2x^4 - 9x^2 - 5x - 6$$
$$q(x) = -8x^5 - 2x^4 + 7x^3 + x + 5$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$p(x) = (-8)x^5 + (-2)x^4 + (0)x^3 + (-9)x^2 + (-5)x^1 + (-6)x^0$$
$$q(x) = (-8)x^5 + (-2)x^4 + (7)x^3 + (0)x^2 + (1)x^1 + (5)x^0$$
$$p(x) + q(x) = (-16)x^5 + (-4)x^4 + (7)x^3 + (-9)x^2 + (-4)x^1 + (-1)x^0$$
$$p(x) + q(x) = -16x^5 - 4x^4 + 7x^3 - 9x^2 - 4x - 1$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -2x^2 + 6x + 3$$
$$b(x) = -6x + 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-2x^2$	$6x$	3
$-6x$	$12x^3$	$-36x^2$	$-18x$
3	$-6x^2$	$18x$	9

$$a(x) \cdot b(x) = 12x^3 - 36x^2 - 6x^2 - 18x + 18x + 9$$

Combine like terms.

$$a(x) \cdot b(x) = 12x^3 - 42x^2 + 9$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 20)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -2x^3 + 10x^2 + 9x + 14 \\ g(x) &= x - 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	-2	10	9	14
6		-12	-12	-18
	-2	-2	-3	-4

So,

$$\frac{f(x)}{g(x)} = -2x^2 - 2x - 3 + \frac{-4}{x-6}$$

In other words, $h(x) = -2x^2 - 2x - 3$ and the remainder is $R = -4$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -2x^3 + 10x^2 + 9x + 14$. Evaluate $f(6)$.

You could do this the hard way.

$$\begin{aligned} f(6) &= (-2)\cdot(6)^3 \ + \ (10)\cdot(6)^2 \ + \ (9)\cdot(6) \ + \ (14) \\ &= (-2)\cdot(216) \ + \ (10)\cdot(36) \ + \ (9)\cdot(6) \ + \ (14) \\ &= (-432) \ + \ (360) \ + \ (54) \ + \ (14) \\ &= -4 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(6)$ equals the remainder when $f(x)$ is divided by $x-6$. Thus, $f(6) = -4$.

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Polynomial Operations SOLUTIONS (version 21)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -3x^5 + 9x^4 + 2x^3 + 5x + 10$$

$$q(x) = 6x^5 + 3x^3 + 4x^2 - 5x - 9$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-3)x^5 + (9)x^4 + (2)x^3 + (0)x^2 + (5)x^1 + (10)x^0 \\ q(x) &= (6)x^5 + (0)x^4 + (3)x^3 + (4)x^2 + (-5)x^1 + (-9)x^0 \\ p(x) - q(x) &= (-9)x^5 + (9)x^4 + (-1)x^3 + (-4)x^2 + (10)x^1 + (19)x^0 \\ p(x) - q(x) &= -9x^5 + 9x^4 - x^3 - 4x^2 + 10x + 19 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 9x^2 + 8x + 3$$

$$b(x) = -4x + 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$9x^2$	$8x$	3
$-4x$	$-36x^3$	$-32x^2$	$-12x$
3	$27x^2$	$24x$	9

$$a(x) \cdot b(x) = -36x^3 - 32x^2 + 27x^2 - 12x + 24x + 9$$

Combine like terms.

$$a(x) \cdot b(x) = -36x^3 - 5x^2 + 12x + 9$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 21)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 2x^3 - 18x^2 + 16x - 10 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	2	-18	16	-10
8		16	-16	0
	2	-2	0	-10

So,

$$\frac{f(x)}{g(x)} = 2x^2 - 2x + \frac{-10}{x-8}$$

In other words, $h(x) = 2x^2 - 2x$ and the remainder is $R = -10$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 2x^3 - 18x^2 + 16x - 10$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (2)\cdot(8)^3 + (-18)\cdot(8)^2 + (16)\cdot(8) + (-10) \\ &= (2)\cdot(512) + (-18)\cdot(64) + (16)\cdot(8) + (-10) \\ &= (1024) + (-1152) + (128) + (-10) \\ &= -10 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = -10$.

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Polynomial Operations SOLUTIONS (version 22)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) \;=\; 8x^5 + x^4 + 3x^2 - 7x + 4$$

$$q(x) \;=\; x^5 - 2x^3 + 10x^2 + 9x - 5$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (8)x^5 + (1)x^4 + (0)x^3 + (3)x^2 + (-7)x^1 + (4)x^0 \\
q(x) &= (1)x^5 + (0)x^4 + (-2)x^3 + (10)x^2 + (9)x^1 + (-5)x^0 \\
p(x) - q(x) &= (7)x^5 + (1)x^4 + (2)x^3 + (-7)x^2 + (-16)x^1 + (9)x^0 \\
p(x) - q(x) &= 7x^5 + x^4 + 2x^3 - 7x^2 - 16x + 9
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) \;=\; -6x^2 + 3x - 9$$

$$b(x) \;=\; -5x + 4$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-6x^2$	$3x$	-9
$-5x$	$30x^3$	$-15x^2$	$45x$
4	$-24x^2$	$12x$	-36

$$a(x) \cdot b(x) \;=\; 30x^3 - 15x^2 - 24x^2 + 45x + 12x - 36$$

Combine like terms.

$$a(x) \cdot b(x) \;=\; 30x^3 - 39x^2 + 57x - 36$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 22)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -4x^3 + 27x^2 - 17x + 3 \\ g(x) &= x - 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -4 & 27 & -17 & 3 \\ 6 & & -24 & 18 & 6 \\ \hline & -4 & 3 & 1 & 9 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -4x^2 + 3x + 1 + \frac{9}{x-6}$$

In other words, $h(x) = -4x^2 + 3x + 1$ and the remainder is $R = 9$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -4x^3 + 27x^2 - 17x + 3$. Evaluate $f(6)$.

You could do this the hard way.

$$\begin{aligned} f(6) &= (-4)\cdot(6)^3 \ + \ (27)\cdot(6)^2 \ + \ (-17)\cdot(6) \ + \ (3) \\ &= (-4)\cdot(216) \ + \ (27)\cdot(36) \ + \ (-17)\cdot(6) \ + \ (3) \\ &= (-864) \ + \ (972) \ + \ (-102) \ + \ (3) \\ &= 9 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(6)$ equals the remainder when $f(x)$ is divided by $x - 6$. Thus, $f(6) = 9$.

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Polynomial Operations SOLUTIONS (version 23)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 - 3x^3 - 7x^2 - 5x + 2$$

$$q(x) = 4x^5 + 3x^4 + 6x^3 + 7x - 5$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$p(x) = (8)x^5 + (0)x^4 + (-3)x^3 + (-7)x^2 + (-5)x^1 + (2)x^0$$
$$q(x) = (4)x^5 + (3)x^4 + (6)x^3 + (0)x^2 + (7)x^1 + (-5)x^0$$
$$p(x) - q(x) = (4)x^5 + (-3)x^4 + (-9)x^3 + (-7)x^2 + (-12)x^1 + (7)x^0$$
$$p(x) - q(x) = 4x^5 - 3x^4 - 9x^3 - 7x^2 - 12x + 7$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -4x^2 + 8x + 7$$

$$b(x) = -6x + 2$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-4x^2$	$8x$	7
$-6x$	$24x^3$	$-48x^2$	$-42x$
2	$-8x^2$	$16x$	14

$$a(x) \cdot b(x) = 24x^3 - 48x^2 - 8x^2 - 42x + 16x + 14$$

Combine like terms.

$$a(x) \cdot b(x) = 24x^3 - 56x^2 - 26x + 14$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 23)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 3x^3 + 21x^2 + 14x - 26 \\ g(x) &= x + 6 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+6}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	3	21	14	-26
-6		-18	-18	24
	3	3	-4	-2

So,

$$\frac{f(x)}{g(x)} = 3x^2 + 3x - 4 + \frac{-2}{x+6}$$

In other words, $h(x) = 3x^2 + 3x - 4$ and the remainder is $R = -2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 3x^3 + 21x^2 + 14x - 26$. Evaluate $f(-6)$.

You could do this the hard way.

$$\begin{aligned} f(-6) &= (3)\cdot(-6)^3 \ + \ (21)\cdot(-6)^2 \ + \ (14)\cdot(-6) \ + \ (-26) \\ &= (3)\cdot(-216) \ + \ (21)\cdot(36) \ + \ (14)\cdot(-6) \ + \ (-26) \\ &= (-648) \ + \ (756) \ + \ (-84) \ + \ (-26) \\ &= -2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-6)$ equals the remainder when $f(x)$ is divided by $x + 6$. Thus, $f(-6) = -2$.

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Polynomial Operations SOLUTIONS (version 24)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 7x^4 + 2x^3 + 5x - 10$$

$$q(x) = -8x^5 - 7x^4 + 10x^3 - x^2 - 6$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (8)x^5 + (7)x^4 + (2)x^3 + (0)x^2 + (5)x^1 + (-10)x^0 \\ q(x) &= (-8)x^5 + (-7)x^4 + (10)x^3 + (-1)x^2 + (0)x^1 + (-6)x^0 \\ p(x) - q(x) &= (16)x^5 + (14)x^4 + (-8)x^3 + (1)x^2 + (5)x^1 + (-4)x^0 \\ p(x) - q(x) &= 16x^5 + 14x^4 - 8x^3 + x^2 + 5x - 4 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -2x^2 + 5x - 4$$

$$b(x) = 6x + 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-2x^2$	$5x$	-4
$6x$	$-12x^3$	$30x^2$	$-24x$
5	$-10x^2$	$25x$	-20

$$a(x) \cdot b(x) = -12x^3 + 30x^2 - 10x^2 - 24x + 25x - 20$$

Combine like terms.

$$a(x) \cdot b(x) = -12x^3 + 20x^2 + x - 20$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 24)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 + 12x^2 + 28x + 11 \\ g(x) &= x + 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & 1 & 12 & 28 & 11 \\ -9 & & -9 & -27 & -9 \\ \hline & 1 & 3 & 1 & 2 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = x^2 + 3x + 1 + \frac{2}{x+9}$$

In other words, $h(x) = x^2 + 3x + 1$ and the remainder is $R = 2$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 + 12x^2 + 28x + 11$. Evaluate $f(-9)$.

You could do this the hard way.

$$\begin{aligned} f(-9) &= (1)\cdot(-9)^3 \;+\; (12)\cdot(-9)^2 \;+\; (28)\cdot(-9) \;+\; (11) \\ &= (1)\cdot(-729) \;+\; (12)\cdot(81) \;+\; (28)\cdot(-9) \;+\; (11) \\ &= (-729) \;+\; (972) \;+\; (-252) \;+\; (11) \\ &= 2 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-9)$ equals the remainder when $f(x)$ is divided by $x + 9$. Thus, $f(-9) = 2$.

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Polynomial Operations SOLUTIONS (version 25)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 9x^4 + x^3 + 2x - 3$$

$$q(x) = 9x^5 - 2x^3 - 3x^2 + 5x + 1$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$p(x) = (8)x^5 + (9)x^4 + (1)x^3 + (0)x^2 + (2)x^1 + (-3)x^0$$
$$q(x) = (9)x^5 + (0)x^4 + (-2)x^3 + (-3)x^2 + (5)x^1 + (1)x^0$$
$$p(x) + q(x) = (17)x^5 + (9)x^4 + (-1)x^3 + (-3)x^2 + (7)x^1 + (-2)x^0$$
$$p(x) + q(x) = 17x^5 + 9x^4 - x^3 - 3x^2 + 7x - 2$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -2x^2 - 6x + 8$$

$$b(x) = -6x - 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-2x^2$	$-6x$	8
$-6x$	$12x^3$	$36x^2$	$-48x$
-5	$10x^2$	$30x$	-40

$$a(x) \cdot b(x) = 12x^3 + 36x^2 + 10x^2 - 48x + 30x - 40$$

Combine like terms.

$$a(x) \cdot b(x) = 12x^3 + 46x^2 - 18x - 40$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 25)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 2x^3 + 16x^2 + 13x - 4 \\ g(x) &= x + 7 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+7}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 2 & 16 & 13 & -4 \\ -7 & & -14 & -14 & 7 \\ \hline & 2 & 2 & -1 & 3 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 2x^2 + 2x - 1 + \frac{3}{x+7}$$

In other words, $h(x) = 2x^2 + 2x - 1$ and the remainder is $R = 3$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 2x^3 + 16x^2 + 13x - 4$. Evaluate $f(-7)$.

You could do this the hard way.

$$\begin{aligned} f(-7) &= (2)\cdot(-7)^3 \ + \ (16)\cdot(-7)^2 \ + \ (13)\cdot(-7) \ + \ (-4) \\ &= (2)\cdot(-343) \ + \ (16)\cdot(49) \ + \ (13)\cdot(-7) \ + \ (-4) \\ &= (-686) \ + \ (784) \ + \ (-91) \ + \ (-4) \\ &= 3 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-7)$ equals the remainder when $f(x)$ is divided by $x + 7$. Thus, $f(-7) = 3$.

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Polynomial Operations SOLUTIONS (version 26)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 3x^4 + x^3 + 7x^2 - 4$$

$$q(x) = -3x^5 + 10x^4 - 8x^3 + 5x - 4$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (8)x^5 + (3)x^4 + (1)x^3 + (7)x^2 + (0)x^1 + (-4)x^0 \\ q(x) &= (-3)x^5 + (10)x^4 + (-8)x^3 + (0)x^2 + (5)x^1 + (-4)x^0 \\ q(x) - p(x) &= (-11)x^5 + (7)x^4 + (-9)x^3 + (-7)x^2 + (5)x^1 + (0)x^0 \\ q(x) - p(x) &= -11x^5 + 7x^4 - 9x^3 - 7x^2 + 5x \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 6x^2 + 2x - 9$$

$$b(x) = -5x - 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$6x^2$	$2x$	-9
$-5x$	$-30x^3$	$-10x^2$	$45x$
-3	$-18x^2$	$-6x$	27

$$a(x) \cdot b(x) = -30x^3 - 10x^2 - 18x^2 + 45x - 6x + 27$$

Combine like terms.

$$a(x) \cdot b(x) = -30x^3 - 28x^2 + 39x + 27$$

3. Express $(x+1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 26)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -6x^3 - 29x^2 + 7x + 18 \\ g(x) &= x + 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -6 & -29 & 7 & 18 \\ -5 & & 30 & -5 & -10 \\ \hline & -6 & 1 & 2 & 8 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -6x^2 + x + 2 + \frac{8}{x+5}$$

In other words, $h(x) = -6x^2 + x + 2$ and the remainder is $R = 8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -6x^3 - 29x^2 + 7x + 18$. Evaluate $f(-5)$.

You could do this the hard way.

$$\begin{aligned} f(-5) &= (-6)\cdot(-5)^3 \ + \ (-29)\cdot(-5)^2 \ + \ (7)\cdot(-5) \ + \ (18) \\ &= (-6)\cdot(-125) \ + \ (-29)\cdot(25) \ + \ (7)\cdot(-5) \ + \ (18) \\ &= (750) \ + \ (-725) \ + \ (-35) \ + \ (18) \\ &= 8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-5)$ equals the remainder when $f(x)$ is divided by $x + 5$. Thus, $f(-5) = 8$.

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Polynomial Operations SOLUTIONS (version 27)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -6x^5 - 8x^3 - 3x^2 - x - 10$$

$$q(x) = -8x^5 - x^4 + 9x^2 - 6x - 10$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-6)x^5 + (0)x^4 + (-8)x^3 + (-3)x^2 + (-1)x^1 + (-10)x^0 \\ q(x) &= (-8)x^5 + (-1)x^4 + (0)x^3 + (9)x^2 + (-6)x^1 + (-10)x^0 \\ p(x) + q(x) &= (-14)x^5 + (-1)x^4 + (-8)x^3 + (6)x^2 + (-7)x^1 + (-20)x^0 \\ p(x) + q(x) &= -14x^5 - x^4 - 8x^3 + 6x^2 - 7x - 20 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -6x^2 - 3x - 5$$

$$b(x) = -9x + 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-6x^2$	$-3x$	-5
$-9x$	$54x^3$	$27x^2$	$45x$
5	$-30x^2$	$-15x$	-25

$$a(x) \cdot b(x) = 54x^3 + 27x^2 - 30x^2 + 45x - 15x - 25$$

Combine like terms.

$$a(x) \cdot b(x) = 54x^3 - 3x^2 + 30x - 25$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 27)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 7x^3 + 29x^2 - 29x + 13 \\ g(x) &= x + 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 7 & 29 & -29 & 13 \\ -5 & & -35 & 30 & -5 \\ \hline & 7 & -6 & 1 & 8 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 7x^2 - 6x + 1 + \frac{8}{x+5}$$

In other words, $h(x) = 7x^2 - 6x + 1$ and the remainder is $R = 8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 7x^3 + 29x^2 - 29x + 13$. Evaluate $f(-5)$.

You could do this the hard way.

$$\begin{aligned} f(-5) &= (7)\cdot(-5)^3 \ + \ (29)\cdot(-5)^2 \ + \ (-29)\cdot(-5) \ + \ (13) \\ &= (7)\cdot(-125) \ + \ (29)\cdot(25) \ + \ (-29)\cdot(-5) \ + \ (13) \\ &= (-875) \ + \ (725) \ + \ (145) \ + \ (13) \\ &= 8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-5)$ equals the remainder when $f(x)$ is divided by $x + 5$. Thus, $f(-5) = 8$.

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Polynomial Operations SOLUTIONS (version 28)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$\begin{aligned} p(x) &= -9x^5 - 2x^3 + 6x^2 - 5x - 3 \\ q(x) &= 8x^5 + 10x^4 + 9x^3 - 5x^2 - 1 \end{aligned}$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-9)x^5 + (0)x^4 + (-2)x^3 + (6)x^2 + (-5)x^1 + (-3)x^0 \\ q(x) &= (8)x^5 + (10)x^4 + (9)x^3 + (-5)x^2 + (0)x^1 + (-1)x^0 \\ q(x) - p(x) &= (17)x^5 + (10)x^4 + (11)x^3 + (-11)x^2 + (5)x^1 + (2)x^0 \\ q(x) - p(x) &= 17x^5 + 10x^4 + 11x^3 - 11x^2 + 5x + 2 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$\begin{aligned} a(x) &= 9x^2 + 3x + 8 \\ b(x) &= 4x + 6 \end{aligned}$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$9x^2$	$3x$	8
$4x$	$36x^3$	$12x^2$	$32x$
6	$54x^2$	$18x$	48

$$a(x) \cdot b(x) = 36x^3 + 12x^2 + 54x^2 + 32x + 18x + 48$$

Combine like terms.

$$a(x) \cdot b(x) = 36x^3 + 66x^2 + 50x + 48$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 28)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 - 8x^2 + x - 13 \\ g(x) &= x - 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 1 & -8 & 1 & -13 \\ 8 & & 8 & 0 & 8 \\ \hline & 1 & 0 & 1 & -5 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = x^2 + 1 + \frac{-5}{x-8}$$

In other words, $h(x) = x^2 + 1$ and the remainder is $R = -5$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 - 8x^2 + x - 13$. Evaluate $f(8)$.

You could do this the hard way.

$$\begin{aligned} f(8) &= (1)\cdot(8)^3 + (-8)\cdot(8)^2 + (1)\cdot(8) + (-13) \\ &= (1)\cdot(512) + (-8)\cdot(64) + (1)\cdot(8) + (-13) \\ &= (512) + (-512) + (8) + (-13) \\ &= -5 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(8)$ equals the remainder when $f(x)$ is divided by $x - 8$. Thus, $f(8) = -5$.

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Polynomial Operations SOLUTIONS (version 29)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -10x^5 + 5x^3 + 3x^2 + 4x + 9$$

$$q(x) = -4x^5 - 6x^4 - 8x^3 + 2x^2 - 3$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-10)x^5 + (0)x^4 + (5)x^3 + (3)x^2 + (4)x^1 + (9)x^0 \\ q(x) &= (-4)x^5 + (-6)x^4 + (-8)x^3 + (2)x^2 + (0)x^1 + (-3)x^0 \\ p(x) + q(x) &= (-14)x^5 + (-6)x^4 + (-3)x^3 + (5)x^2 + (4)x^1 + (6)x^0 \\ p(x) + q(x) &= -14x^5 - 6x^4 - 3x^3 + 5x^2 + 4x + 6 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 6x^2 - 5x - 4$$

$$b(x) = -2x - 8$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$6x^2$	$-5x$	-4
$-2x$	$-12x^3$	$10x^2$	$8x$
-8	$-48x^2$	$40x$	32

$$a(x) \cdot b(x) = -12x^3 + 10x^2 - 48x^2 + 8x + 40x + 32$$

Combine like terms.

$$a(x) \cdot b(x) = -12x^3 - 38x^2 + 48x + 32$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 29)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -4x^3 + 25x^2 + 23x - 13 \\ g(x) &= x - 7 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-7}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -4 & 25 & 23 & -13 \\ 7 & & -28 & -21 & 14 \\ \hline & -4 & -3 & 2 & 1 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -4x^2 - 3x + 2 + \frac{1}{x-7}$$

In other words, $h(x) = -4x^2 - 3x + 2$ and the remainder is $R = 1$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -4x^3 + 25x^2 + 23x - 13$. Evaluate $f(7)$.

You could do this the hard way.

$$\begin{aligned} f(7) &= (-4)\cdot(7)^3 \; + \; (25)\cdot(7)^2 \; + \; (23)\cdot(7) \; + \; (-13) \\ &= (-4)\cdot(343) \; + \; (25)\cdot(49) \; + \; (23)\cdot(7) \; + \; (-13) \\ &= (-1372) \; + \; (1225) \; + \; (161) \; + \; (-13) \\ &= 1 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(7)$ equals the remainder when $f(x)$ is divided by $x - 7$. Thus, $f(7) = 1$.

Name: ______________________________ Date: ______________

Polynomial Operations SOLUTIONS (version 30)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -2x^5 + 3x^4 + x^2 - 9x + 10$$

$$q(x) = 3x^5 + x^3 - 5x^2 - 8x + 6$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-2)x^5 + (3)x^4 + (0)x^3 + (1)x^2 + (-9)x^1 + (10)x^0 \\ q(x) &= (3)x^5 + (0)x^4 + (1)x^3 + (-5)x^2 + (-8)x^1 + (6)x^0 \\ q(x) - p(x) &= (5)x^5 + (-3)x^4 + (1)x^3 + (-6)x^2 + (1)x^1 + (-4)x^0 \\ q(x) - p(x) &= 5x^5 - 3x^4 + x^3 - 6x^2 + x - 4 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -2x^2 + 5x - 3$$

$$b(x) = -7x - 4$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-2x^2$	$5x$	-3
$-7x$	$14x^3$	$-35x^2$	$21x$
-4	$8x^2$	$-20x$	12

$$a(x) \cdot b(x) = 14x^3 - 35x^2 + 8x^2 + 21x - 20x + 12$$

Combine like terms.

$$a(x) \cdot b(x) = 14x^3 - 27x^2 + x + 12$$

3. Express $(x+1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 30)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -2x^3 - 16x^2 - 2x - 20 \\ g(x) &= x + 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	-2	-16	-2	-20
-8		16	0	16
	-2	0	-2	-4

So,

$$\frac{f(x)}{g(x)} = -2x^2 - 2 + \frac{-4}{x+8}$$

In other words, $h(x) = -2x^2 - 2$ and the remainder is $R = -4$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -2x^3 - 16x^2 - 2x - 20$. Evaluate $f(-8)$.

You could do this the hard way.

$$\begin{aligned} f(-8) &= (-2) \cdot (-8)^3 \ + \ (-16) \cdot (-8)^2 \ + \ (-2) \cdot (-8) \ + \ (-20) \\ &= (-2) \cdot (-512) \ + \ (-16) \cdot (64) \ + \ (-2) \cdot (-8) \ + \ (-20) \\ &= (1024) \ + \ (-1024) \ + \ (16) \ + \ (-20) \\ &= \ -4 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-8)$ equals the remainder when $f(x)$ is divided by $x + 8$. Thus, $f(-8) = -4$.

Name: ____________________ Date: ____________________

Polynomial Operations SOLUTIONS (version 31)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -8x^5 + 3x^3 + 6x^2 + x + 10$$

$$q(x) = 2x^5 + x^4 - 6x^3 - 8x^2 + 9$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-8)x^5 + (0)x^4 + (3)x^3 + (6)x^2 + (1)x^1 + (10)x^0 \\ q(x) &= (2)x^5 + (1)x^4 + (-6)x^3 + (-8)x^2 + (0)x^1 + (9)x^0 \\ p(x) - q(x) &= (-10)x^5 + (-1)x^4 + (9)x^3 + (14)x^2 + (1)x^1 + (1)x^0 \\ p(x) - q(x) &= -10x^5 - x^4 + 9x^3 + 14x^2 + x + 1 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -9x^2 - 7x + 3$$

$$b(x) = 3x - 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-9x^2$	$-7x$	3
$3x$	$-27x^3$	$-21x^2$	$9x$
-7	$63x^2$	$49x$	-21

$$a(x) \cdot b(x) = -27x^3 - 21x^2 + 63x^2 + 9x + 49x - 21$$

Combine like terms.

$$a(x) \cdot b(x) = -27x^3 + 42x^2 + 58x - 21$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 31)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 3x^3 - 12x^2 + x - 5 \\ g(x) &= x - 4 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-4}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 3 & -12 & 1 & -5 \\ 4 & & 12 & 0 & 4 \\ \hline & 3 & 0 & 1 & -1 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 3x^2 + 1 + \frac{-1}{x-4}$$

In other words, $h(x) = 3x^2 + 1$ and the remainder is $R = -1$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 3x^3 - 12x^2 + x - 5$. Evaluate $f(4)$.

You could do this the hard way.

$$\begin{aligned} f(4) &= (3)\cdot(4)^3 \;+\; (-12)\cdot(4)^2 \;+\; (1)\cdot(4) \;+\; (-5) \\ &= (3)\cdot(64) \;+\; (-12)\cdot(16) \;+\; (1)\cdot(4) \;+\; (-5) \\ &= (192) \;+\; (-192) \;+\; (4) \;+\; (-5) \\ &= -1 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(4)$ equals the remainder when $f(x)$ is divided by $x - 4$. Thus, $f(4) = -1$.

Name:______________________________ Date:______________

Polynomial Operations SOLUTIONS (version 32)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) \;=\; 4x^5 - 9x^4 + x^3 + 3x - 6$$

$$q(x) \;=\; -3x^5 + 9x^4 - 6x^2 + 4x - 5$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (4)x^5 + (-9)x^4 + (1)x^3 + (0)x^2 + (3)x^1 + (-6)x^0 \\ q(x) &= (-3)x^5 + (9)x^4 + (0)x^3 + (-6)x^2 + (4)x^1 + (-5)x^0 \\ p(x) - q(x) &= (7)x^5 + (-18)x^4 + (1)x^3 + (6)x^2 + (-1)x^1 + (-1)x^0 \\ p(x) - q(x) &= 7x^5 - 18x^4 + x^3 + 6x^2 - x - 1 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) \;=\; -8x^2 - 3x + 9$$

$$b(x) \;=\; -5x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-8x^2$	$-3x$	9
$-5x$	$40x^3$	$15x^2$	$-45x$
7	$-56x^2$	$-21x$	63

$$a(x) \cdot b(x) \;=\; 40x^3 + 15x^2 - 56x^2 - 45x - 21x + 63$$

Combine like terms.

$$a(x) \cdot b(x) \;=\; 40x^3 - 41x^2 - 66x + 63$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 32)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -x^3 - 9x^2 + 3x + 20 \\ g(x) &= x + 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & -1 & -9 & 3 & 20 \\ -9 & & 9 & 0 & -27 \\ \hline & -1 & 0 & 3 & -7 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = -x^2 + 3 + \frac{-7}{x+9}$$

In other words, $h(x) = -x^2 + 3$ and the remainder is $R = -7$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -x^3 - 9x^2 + 3x + 20$. Evaluate $f(-9)$.

You could do this the hard way.

$$\begin{aligned} f(-9) &= (-1)\cdot(-9)^3 + (-9)\cdot(-9)^2 + (3)\cdot(-9) + (20) \\ &= (-1)\cdot(-729) + (-9)\cdot(81) + (3)\cdot(-9) + (20) \\ &= (729) + (-729) + (-27) + (20) \\ &= -7 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-9)$ equals the remainder when $f(x)$ is divided by $x+9$. Thus, $f(-9) = -7$.

Name: ____________________ Date: ____________________

Polynomial Operations SOLUTIONS (version 33)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -9x^5 + 2x^4 - 4x^2 + x + 5$$

$$q(x) = 6x^5 + 2x^4 + 10x^3 - 4x^2 - 3$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned}
p(x) &= (-9)x^5 + (2)x^4 + (0)x^3 + (-4)x^2 + (1)x^1 + (5)x^0 \\
q(x) &= (6)x^5 + (2)x^4 + (10)x^3 + (-4)x^2 + (0)x^1 + (-3)x^0 \\
p(x) + q(x) &= (-3)x^5 + (4)x^4 + (10)x^3 + (-8)x^2 + (1)x^1 + (2)x^0 \\
p(x) + q(x) &= -3x^5 + 4x^4 + 10x^3 - 8x^2 + x + 2
\end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -7x^2 - 5x + 2$$

$$b(x) = -8x + 7$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-7x^2$	$-5x$	2
$-8x$	$56x^3$	$40x^2$	$-16x$
7	$-49x^2$	$-35x$	14

$$a(x) \cdot b(x) = 56x^3 + 40x^2 - 49x^2 - 16x - 35x + 14$$

Combine like terms.

$$a(x) \cdot b(x) = 56x^3 - 9x^2 - 51x + 14$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 33)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 5x^3 + 15x^2 - 19x + 12 \\ g(x) &= x + 4 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+4}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	5	15	-19	12
-4		-20	20	-4
	5	-5	1	8

So,

$$\frac{f(x)}{g(x)} = 5x^2 - 5x + 1 + \frac{8}{x+4}$$

In other words, $h(x) = 5x^2 - 5x + 1$ and the remainder is $R = 8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 5x^3 + 15x^2 - 19x + 12$. Evaluate $f(-4)$.

You could do this the hard way.

$$\begin{aligned} f(-4) &= (5)\cdot(-4)^3 \ + \ (15)\cdot(-4)^2 \ + \ (-19)\cdot(-4) \ + \ (12) \\ &= (5)\cdot(-64) \ + \ (15)\cdot(16) \ + \ (-19)\cdot(-4) \ + \ (12) \\ &= (-320) \ + \ (240) \ + \ (76) \ + \ (12) \\ &= 8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-4)$ equals the remainder when $f(x)$ is divided by $x + 4$. Thus, $f(-4) = 8$.

Name: ____ Date: ____________________

Polynomial Operations SOLUTIONS (version 34)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$\begin{aligned} p(x) &= -9x^5 + 8x^3 + 6x^2 + 7x + 4 \\ q(x) &= 3x^5 - 10x^4 + x^3 - 9x^2 - 8 \end{aligned}$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-9)x^5 + (0)x^4 + (8)x^3 + (6)x^2 + (7)x^1 + (4)x^0 \\ q(x) &= (3)x^5 + (-10)x^4 + (1)x^3 + (-9)x^2 + (0)x^1 + (-8)x^0 \\ q(x) - p(x) &= (12)x^5 + (-10)x^4 + (-7)x^3 + (-15)x^2 + (-7)x^1 + (-12)x^0 \\ q(x) - p(x) &= 12x^5 - 10x^4 - 7x^3 - 15x^2 - 7x - 12 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$\begin{aligned} a(x) &= 2x^2 - 8x - 4 \\ b(x) &= 5x + 6 \end{aligned}$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$2x^2$	$-8x$	-4
$5x$	$10x^3$	$-40x^2$	$-20x$
6	$12x^2$	$-48x$	-24

$$a(x) \cdot b(x) = 10x^3 - 40x^2 + 12x^2 - 20x - 48x - 24$$

Combine like terms.

$$a(x) \cdot b(x) = 10x^3 - 28x^2 - 68x - 24$$

3. Express $(x + 1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 34)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 2x^3 + 16x^2 + 11x - 26 \\ g(x) &= x + 7 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+7}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 2 & 16 & 11 & -26 \\ -7 & & -14 & -14 & 21 \\ \hline & 2 & 2 & -3 & -5 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 2x^2 + 2x - 3 + \frac{-5}{x+7}$$

In other words, $h(x) = 2x^2 + 2x - 3$ and the remainder is $R = -5$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 2x^3 + 16x^2 + 11x - 26$. Evaluate $f(-7)$.

You could do this the hard way.

$$\begin{aligned} f(-7) &= (2)\cdot(-7)^3 \ + \ (16)\cdot(-7)^2 \ + \ (11)\cdot(-7) \ + \ (-26) \\ &= (2)\cdot(-343) \ + \ (16)\cdot(49) \ + \ (11)\cdot(-7) \ + \ (-26) \\ &= (-686) \ + \ (784) \ + \ (-77) \ + \ (-26) \\ &= -5 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-7)$ equals the remainder when $f(x)$ is divided by $x + 7$. Thus, $f(-7) = -5$.

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Polynomial Operations SOLUTIONS (version 35)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + x^4 - 3x^2 + 9x - 5$$

$$q(x) = 9x^5 - 5x^4 - x^3 - 3x^2 - 10$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (8)x^5 + (1)x^4 + (0)x^3 + (-3)x^2 + (9)x^1 + (-5)x^0 \\ q(x) &= (9)x^5 + (-5)x^4 + (-1)x^3 + (-3)x^2 + (0)x^1 + (-10)x^0 \\ p(x) - q(x) &= (-1)x^5 + (6)x^4 + (1)x^3 + (0)x^2 + (9)x^1 + (5)x^0 \\ p(x) - q(x) &= -x^5 + 6x^4 + x^3 + 9x + 5 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -6x^2 - 5x + 3$$

$$b(x) = -9x + 6$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-6x^2$	$-5x$	3
$-9x$	$54x^3$	$45x^2$	$-27x$
6	$-36x^2$	$-30x$	18

$$a(x) \cdot b(x) = 54x^3 + 45x^2 - 36x^2 - 27x - 30x + 18$$

Combine like terms.

$$a(x) \cdot b(x) = 54x^3 + 9x^2 - 57x + 18$$

3. Express $(x + 1)^6$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^6 + 6x^5 + 15x^4 + 20x^3 + 15x^2 + 6x + 1$$

Polynomial Operations SOLUTIONS (version 35)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= -3x^3 - 24x^2 + x + 18 \\ g(x) &= x + 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	-3	-24	1	18
-8		24	0	-8
	-3	0	1	10

So,

$$\frac{f(x)}{g(x)} = -3x^2 + 1 + \frac{10}{x+8}$$

In other words, $h(x) = -3x^2 + 1$ and the remainder is $R = 10$.

5. Let polynomial $f(x)$ still be defined as $f(x) = -3x^3 - 24x^2 + x + 18$. Evaluate $f(-8)$.

You could do this the hard way.

$$\begin{aligned} f(-8) &= (-3)\cdot(-8)^3 \ + \ (-24)\cdot(-8)^2 \ + \ (1)\cdot(-8) \ + \ (18) \\ &= (-3)\cdot(-512) \ + \ (-24)\cdot(64) \ + \ (1)\cdot(-8) \ + \ (18) \\ &= (1536) \ + \ (-1536) \ + \ (-8) \ + \ (18) \\ &= 10 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-8)$ equals the remainder when $f(x)$ is divided by $x + 8$. Thus, $f(-8) = 10$.

Name: ____________________ Date: ____________

Polynomial Operations SOLUTIONS (version 36)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -3x^5 - 8x^3 - x^2 - 2x + 9$$

$$q(x) = -5x^5 + 8x^4 + 6x^2 + 2x - 3$$

Express the difference $q(x) - p(x)$ in standard form.

Get "unsimplified" forms. Then find $q(x) - p(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-3)x^5 + (0)x^4 + (-8)x^3 + (-1)x^2 + (-2)x^1 + (9)x^0 \\ q(x) &= (-5)x^5 + (8)x^4 + (0)x^3 + (6)x^2 + (2)x^1 + (-3)x^0 \\ q(x) - p(x) &= (-2)x^5 + (8)x^4 + (8)x^3 + (7)x^2 + (4)x^1 + (-12)x^0 \\ q(x) - p(x) &= -2x^5 + 8x^4 + 8x^3 + 7x^2 + 4x - 12 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -3x^2 - 6x - 5$$

$$b(x) = 4x + 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-3x^2$	$-6x$	-5
$4x$	$-12x^3$	$-24x^2$	$-20x$
5	$-15x^2$	$-30x$	-25

$$a(x) \cdot b(x) = -12x^3 - 24x^2 - 15x^2 - 20x - 30x - 25$$

Combine like terms.

$$a(x) \cdot b(x) = -12x^3 - 39x^2 - 50x - 25$$

3. Express $(x+1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 36)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 3x^3 - 25x^2 - 18x + 10 \\ g(x) &= x - 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & 3 & -25 & -18 & 10 \\ 9 & & 27 & 18 & 0 \\ \hline & 3 & 2 & 0 & 10 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 3x^2 + 2x + \frac{10}{x-9}$$

In other words, $h(x) = 3x^2 + 2x$ and the remainder is $R = 10$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 3x^3 - 25x^2 - 18x + 10$. Evaluate $f(9)$.

You could do this the hard way.

$$\begin{aligned} f(9) &= (3)\cdot(9)^3 \ + \ (-25)\cdot(9)^2 \ + \ (-18)\cdot(9) \ + \ (10) \\ &= (3)\cdot(729) \ + \ (-25)\cdot(81) \ + \ (-18)\cdot(9) \ + \ (10) \\ &= (2187) \ + \ (-2025) \ + \ (-162) \ + \ (10) \\ &= 10 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(9)$ equals the remainder when $f(x)$ is divided by $x - 9$. Thus, $f(9) = 10$.

Name:______________________________ Date:______________

Polynomial Operations SOLUTIONS (version 37)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = 8x^5 + 2x^4 - 5x^2 + 4x - 1$$

$$q(x) = 3x^5 - x^4 - 4x^3 + 7x + 2$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$p(x) = (8)x^5 + (2)x^4 + (0)x^3 + (-5)x^2 + (4)x^1 + (-1)x^0$$
$$q(x) = (3)x^5 + (-1)x^4 + (-4)x^3 + (0)x^2 + (7)x^1 + (2)x^0$$
$$p(x) + q(x) = (11)x^5 + (1)x^4 + (-4)x^3 + (-5)x^2 + (11)x^1 + (1)x^0$$
$$p(x) + q(x) = 11x^5 + x^4 - 4x^3 - 5x^2 + 11x + 1$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 4x^2 + 8x - 7$$

$$b(x) = -2x - 5$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$4x^2$	$8x$	-7
$-2x$	$-8x^3$	$-16x^2$	$14x$
-5	$-20x^2$	$-40x$	35

$$a(x) \cdot b(x) = -8x^3 - 16x^2 - 20x^2 + 14x - 40x + 35$$

Combine like terms.

$$a(x) \cdot b(x) = -8x^3 - 36x^2 - 26x + 35$$

3. Express $(x + 1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 37)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 3x^3 + 25x^2 + 12x + 23 \\ g(x) &= x + 8 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+8}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	3	25	12	23
-8		-24	-8	-32
	3	1	4	-9

So,

$$\frac{f(x)}{g(x)} = 3x^2 + x + 4 + \frac{-9}{x+8}$$

In other words, $h(x) = 3x^2 + x + 4$ and the remainder is $R = -9$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 3x^3 + 25x^2 + 12x + 23$. Evaluate $f(-8)$.

You could do this the hard way.

$$\begin{aligned} f(-8) &= (3)\cdot(-8)^3 \;+\; (25)\cdot(-8)^2 \;+\; (12)\cdot(-8) \;+\; (23) \\ &= (3)\cdot(-512) \;+\; (25)\cdot(64) \;+\; (12)\cdot(-8) \;+\; (23) \\ &= (-1536) \;+\; (1600) \;+\; (-96) \;+\; (23) \\ &= -9 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-8)$ equals the remainder when $f(x)$ is divided by $x+8$. Thus, $f(-8) = -9$.

Name: Date:

Polynomial Operations SOLUTIONS (version 38)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -5x^5 + 2x^3 - 4x^2 + 8x + 7$$

$$q(x) = -8x^5 - 9x^4 - 6x^3 + 5x^2 - 10$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-5)x^5 + (0)x^4 + (2)x^3 + (-4)x^2 + (8)x^1 + (7)x^0 \\ q(x) &= (-8)x^5 + (-9)x^4 + (-6)x^3 + (5)x^2 + (0)x^1 + (-10)x^0 \\ p(x) - q(x) &= (3)x^5 + (9)x^4 + (8)x^3 + (-9)x^2 + (8)x^1 + (17)x^0 \\ p(x) - q(x) &= 3x^5 + 9x^4 + 8x^3 - 9x^2 + 8x + 17 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = 8x^2 + 6x - 9$$

$$b(x) = -6x - 4$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$8x^2$	$6x$	-9
$-6x$	$-48x^3$	$-36x^2$	$54x$
-4	$-32x^2$	$-24x$	36

$$a(x) \cdot b(x) = -48x^3 - 36x^2 - 32x^2 + 54x - 24x + 36$$

Combine like terms.

$$a(x) \cdot b(x) = -48x^3 - 68x^2 + 30x + 36$$

3. Express $(x+1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 38)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 4x^3 - 25x^2 - 25x + 22 \\ g(x) &= x - 7 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-7}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

	4	-25	-25	22
7		28	21	-28
	4	3	-4	-6

So,

$$\frac{f(x)}{g(x)} = 4x^2 + 3x - 4 + \frac{-6}{x-7}$$

In other words, $h(x) = 4x^2 + 3x - 4$ and the remainder is $R = -6$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 4x^3 - 25x^2 - 25x + 22$. Evaluate $f(7)$.

You could do this the hard way.

$$\begin{aligned} f(7) &= (4)\cdot(7)^3 \; + \; (-25)\cdot(7)^2 \; + \; (-25)\cdot(7) \; + \; (22) \\ &= (4)\cdot(343) \; + \; (-25)\cdot(49) \; + \; (-25)\cdot(7) \; + \; (22) \\ &= (1372) \; + \; (-1225) \; + \; (-175) \; + \; (22) \\ &= -6 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(7)$ equals the remainder when $f(x)$ is divided by $x - 7$. Thus, $f(7) = -6$.

Name: ______________________________ Date: ______________

Polynomial Operations SOLUTIONS (version 39)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -8x^5 + 2x^3 + 5x^2 - 6x + 4$$

$$q(x) = -8x^5 - 10x^4 - 7x^3 + x - 5$$

Express the difference $p(x) - q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) - q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-8)x^5 + (0)x^4 + (2)x^3 + (5)x^2 + (-6)x^1 + (4)x^0 \\ q(x) &= (-8)x^5 + (-10)x^4 + (-7)x^3 + (0)x^2 + (1)x^1 + (-5)x^0 \\ p(x) - q(x) &= (0)x^5 + (10)x^4 + (9)x^3 + (5)x^2 + (-7)x^1 + (9)x^0 \\ p(x) - q(x) &= 10x^4 + 9x^3 + 5x^2 - 7x + 9 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -8x^2 - 3x + 7$$

$$b(x) = -2x + 3$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-8x^2$	$-3x$	7
$-2x$	$16x^3$	$6x^2$	$-14x$
3	$-24x^2$	$-9x$	21

$$a(x) \cdot b(x) = 16x^3 + 6x^2 - 24x^2 - 14x - 9x + 21$$

Combine like terms.

$$a(x) \cdot b(x) = 16x^3 - 18x^2 - 23x + 21$$

3. Express $(x+1)^4$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^4 + 4x^3 + 6x^2 + 4x + 1$$

Polynomial Operations SOLUTIONS (version 39)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= 7x^3 - 29x^2 - 29x - 13 \\ g(x) &= x - 5 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x-5}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{c|cccc} & 7 & -29 & -29 & -13 \\ 5 & & 35 & 30 & 5 \\ \hline & 7 & 6 & 1 & -8 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = 7x^2 + 6x + 1 + \frac{-8}{x-5}$$

In other words, $h(x) = 7x^2 + 6x + 1$ and the remainder is $R = -8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = 7x^3 - 29x^2 - 29x - 13$. Evaluate $f(5)$.

You could do this the hard way.

$$\begin{aligned} f(5) &= (7)\cdot(5)^3 \ + \ (-29)\cdot(5)^2 \ + \ (-29)\cdot(5) \ + \ (-13) \\ &= (7)\cdot(125) \ + \ (-29)\cdot(25) \ + \ (-29)\cdot(5) \ + \ (-13) \\ &= (875) \ + \ (-725) \ + \ (-145) \ + \ (-13) \\ &= -8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(5)$ equals the remainder when $f(x)$ is divided by $x - 5$. Thus, $f(5) = -8$.

Name: ____ Date: ____________________

Polynomial Operations SOLUTIONS (version 40)

1. Let polynomials $p(x)$ and $q(x)$ be defined below.

$$p(x) = -2x^5 + 10x^4 + 8x^3 - 5x^2 - 7$$

$$q(x) = 8x^5 + 7x^4 + 5x^3 - 10x - 2$$

Express the sum of $p(x) + q(x)$ in standard form.

Get "unsimplified" forms. Then find $p(x) + q(x)$ with addition/subtraction.

$$\begin{aligned} p(x) &= (-2)x^5 + (10)x^4 + (8)x^3 + (-5)x^2 + (0)x^1 + (-7)x^0 \\ q(x) &= (8)x^5 + (7)x^4 + (5)x^3 + (0)x^2 + (-10)x^1 + (-2)x^0 \\ p(x) + q(x) &= (6)x^5 + (17)x^4 + (13)x^3 + (-5)x^2 + (-10)x^1 + (-9)x^0 \\ p(x) + q(x) &= 6x^5 + 17x^4 + 13x^3 - 5x^2 - 10x - 9 \end{aligned}$$

2. Let polynomials $a(x)$ and $b(x)$ be defined below.

$$a(x) = -7x^2 + 6x - 8$$

$$b(x) = -8x - 4$$

Express the product $a(x) \cdot b(x)$ in standard form.

You can use a table for multiplication.

*	$-7x^2$	$6x$	-8
$-8x$	$56x^3$	$-48x^2$	$64x$
-4	$28x^2$	$-24x$	32

$$a(x) \cdot b(x) = 56x^3 - 48x^2 + 28x^2 + 64x - 24x + 32$$

Combine like terms.

$$a(x) \cdot b(x) = 56x^3 - 20x^2 + 40x + 32$$

3. Express $(x+1)^5$ in standard (expanded) form.

Remember the binomial theorem. It tells us to use Pascal's triangle.

$$x^5 + 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Polynomial Operations SOLUTIONS (version 40)

4. Let polynomials $f(x)$ and $g(x)$ be defined below.

$$\begin{aligned} f(x) &= x^3 + 12x^2 + 26x - 1 \\ g(x) &= x + 9 \end{aligned}$$

The quotient of $\frac{f(x)}{g(x)}$ can be expressed as a polynomial, $h(x)$, and a remainder, R (a real number).

$$\frac{f(x)}{g(x)} = h(x) + \frac{R}{x+9}$$

By using synthetic division or long division, express $h(x)$ in standard form, and find the remainder R.

I prefer using synthetic division.

$$\begin{array}{r|rrrr} & 1 & 12 & 26 & -1 \\ -9 & & -9 & -27 & 9 \\ \hline & 1 & 3 & -1 & 8 \end{array}$$

So,

$$\frac{f(x)}{g(x)} = x^2 + 3x - 1 + \frac{8}{x+9}$$

In other words, $h(x) = x^2 + 3x - 1$ and the remainder is $R = 8$.

5. Let polynomial $f(x)$ still be defined as $f(x) = x^3 + 12x^2 + 26x - 1$. Evaluate $f(-9)$.

You could do this the hard way.

$$\begin{aligned} f(-9) &= (1)\cdot(-9)^3 \ + \ (12)\cdot(-9)^2 \ + \ (26)\cdot(-9) \ + \ (-1) \\ &= (1)\cdot(-729) \ + \ (12)\cdot(81) \ + \ (26)\cdot(-9) \ + \ (-1) \\ &= (-729) \ + \ (972) \ + \ (-234) \ + \ (-1) \\ &= 8 \end{aligned}$$

Or, if you reference the polynomial remainder theorem, you can state that you know $f(-9)$ equals the remainder when $f(x)$ is divided by $x+9$. Thus, $f(-9) = 8$.